PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventor: SYDNEY ALFRED RICHARD RIGDEN

865,928

Date of filing Complete Specification Nov. 13, 1959.

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Classes 39(1), D(5A:9A:9B:9C:9D:12A:12B2:12B4:12C:12D:35); **and 56.**

CORRECTION OF CLERICAL ERRORS

SPECIFICATION NO. 865,928

The following corrections are in accordance with the Decision of the Superintending Examiner, acting for the Comptroller-General, dated the twelth day of June, 1961.

Page 3, line 122 and page 8, line 3, *for* "15" *read* "1.5"

Page 3, line 110 and page 7, line 122, *for* "Kryptron" *read* "Krypton"

Attention is also directed to the following Printer's errors:-

Page 1, line 13, *for* "emission" *read* "emissive"

Page 2, line 5, *for* "that" *read* "than"

Page 2, line 121, *after* "comprising" *insert* "a"

Page 3, line 6, *for* "inermediate" *read* "intermediate"

Page 3, line 16, *for* "sshaped" *read* "shaped"

Page 3, line 28, *for* "acocrdance" *read* "accordance"

Page 3, line 121, *for* "milimetres" *read* "millimetres"

Page 4, line 36, *for* "tap" *read* "tag"

Page 4, line 46, *for* "respectitve" *read* "respective"

Page 4, line 121, *for* "diaameter" *read* "diameter"

Page 4, line 121, *for* "les" *read* "less"

Page 5, line 66, *for* "enlongated" *read* "elongated"

Page 7, line 10, *for* "reigons" *read* "regions"

Page 7, line 18, *for* "has" *read* "had"

THE PATENT OFFICE,
1st July, 1961.

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Index at acceptance:—Classes 39(1), D(5A:9A:9B:9C:9D:12A:12B2:12B4:12C:12D:35); and 56, M11B1, MF2, MS5.

International Classification:—H01j. C03b,c.

COMPLETE SPECIFICATION

Improvements in or relating to Sodium Vapour electric discharge lamps

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to sodium vapour electric discharge lamps of the positive column type having an elongated tubular discharge envelope containing a pair of thermionically-emission electrodes located at opposite ends of the envelope, a quantity of sodium for providing for a low pressure sodium vapour electric discharge between the electrodes in normal operation of the lamp, and a filling of rare gas for enabling the lamp to start and the sodium vapour electric discharge to be developed, and relates particularly to such lamps in which the region of the discharge envelope between the electrodes consists of or includes one or more axially straight parts, that is to say one or more parts for which the corresponding length of the tube axis is straight.

The term "low pressure" implies that the lamp is of the kind in which the sodium vapour pressure in normal operation is much less than 1 millimetre mercury, usually about 0.01 millimetre mercury.

The form of sodium vapour electric discharge lamp which is in most common use at the present time has a discharge envelope formed of substantially circular section tubing bent into the shape of the letter U, consisting of two parallel straight limbs joined by a short curved portion, and surrounded by a heat-conserving outer jacket; the invention is particularly, though not exclusively, concerned with sodium vapour lamps of this kind.

One difficulty which has often been experienced with sodium vapour lamps of the type specified is that the sodium filling, which is preferably initially distributed along the length of the discharge path, tends to migrate, due to the phenomenon of thermal diffusion, towards the parts of the envelope which remain relatively cool in operation. Such parts may be few in number and spaced widely apart, and this can result in other parts of the envelope becoming starved of sodium vapour, with a consequent reduction in the light output from those parts and a fall in the efficiency of the lamp as a whole.

The resultant loss in efficiency brought about by the migration of the sodium filling within the envelope often limits the useful life of a sodium lamp of the type specified to an undesirably low value, and the object of the present invention is to provide a form of lamp in which this difficulty is reduced.

According to the invention in a sodium vapour electric discharge lamp of the type specified having a tubular discharge envelope formed from substantially circular section tubing and having in the region between the electrodes at least one axially straight part, the or each said straight part of the envelope is formed with a plurality of flattened regions of relatively long axial length separated by intermediate regions of relatively short axial length having the full substantially circular area of cross-section of the tubing, the flattened regions of the envelope each having an area of cross-section between one quarter and three-quarters that of the intermediate regions and having in each cross-section of the region a maximum diameter which is not less than that of the intermediate regions.

In the above statement of the invention and hereinafter the expression "cross-section" as applied to tubing forming the discharge

envelope means the internal cross-section of the tubing at right angles to its axis.

In operation of such a lamp the flattened regions are maintained at a higher temperature that the intermediate regions owing to the greater current density within them compared with that in the intermediate regions; the intermediate regions thus constitute relatively cool parts of the envelope at which the sodium filling tends to collect due to thermal diffusion, the presence of the sodium in the regions thereby tending to keep the adjoining flattened regions supplied with sodium vapour in use of the lamp. The intermediate regions should, of course, be suitably closely spaced along the discharge envelope.

On the other hand the flattened regions should be sufficiently long, and arranged to operate at such a temperature with respect to the intermediate regions, that the transfer of sodium from one intermediate region to the next is substantially avoided. The temperature at which the flattened regions are maintained in use of the lamp will be determined by their cross-sectional area compared with that of the intermediate regions, and the smaller their cross-section the higher in general, will be their operating temperature.

The cross-sectional area of each flattened region is preferably approximately one half of that of the intermediate regions.

Preferably in each flattened region of the envelope, the envelope wall is flattened on opposite sides of the tube axis, with the flattened parts of the envelope wall in said region preferably lying parallel to each other.

Since the maximum diameter of each of the flattened regions of the envelope is not less than the diameter of the intermediate regions, there will be no appreciable reduction in the width of the discharge in a flattened region as measured in the direction of the maximum diameters; the initial light output from a said flattened region perpendicularly to the maximum diameter will not, therefore, be significantly less than that obtainable in the same direction from a corresponding length of a similar lamp having the same cross-section as the intermediate regions, and may, in fact, be greater, depending upon the particular dimensions of the flattened region, in view of the increased current density. By a suitable choice in the number and size of the flattened regions the light output may in some cases be increased to such an extent that the total light output from the lamp as a whole is improved, despite the reduction in light output in direction parallel to the maximum diameters resulting from the narrowing of the discharge in the minimum width directions of the flattened regions.

In addition owing to the reduction in the rate of sodium migration the light output from a lamp in accordance with the invention is maintained more nearly constant over a longer period of time than is usually the case with sodium lamps of the type specified, the improved lumen maintenance thereby enabling a particularly long useful lamp life to be obtained.

Preferably the maximum diameter of each flattened region is the same as that of the intermediate regions. In some cases however it may be slightly larger, although it will be appreciated that it should not be so large that the edges of the flattened regions, despite the increased current density, are no longer maintained at a higher temperature than are the intermediate regions in use of the lamp, and provide relatively cold parts of the envelope at which the sodium condenses, since this could lead to the sodium gradually migrating along the edges from one intermediate region to another.

The reduction in light output in directions parallel to the said maximum diameters of the flattened regions will in many cases be an advantage rather than a disadvantage.

For example a light source designed for street lighting purposes is usually required to provide a light distribution having two directions of maximum intensity extending generaly up and down the roadway, with the intensity falling off gradually below those directions to a minuimum value immediately beneath the light source. In lamps in accordance with the present invention for use in street lighting and other purposes requiring a similar light distribution the different flattened regions of the envelope are preferably arranged parallel to each other. Such a lamp, when mounted with its axis horizontal, as is usually the case with sodium lamps, can then be arranged with the flattened regions approximately vertical, so that the directions of maximum light output extend approximately horizontally outwards on opposite sides of the lamp axis; the light intensity in transverese vertical planes will then fall off gradually to a minimum value immediately beneath the lamp, thereby giving a light distribution of the form which is generally required for street lighting.

Where the lamp has a U-shaped envelope arranged to be mounted with one of the limbs of the envelope immediately above the other, the flattened regions of both limbs of the envelope are preferably arranged parallel to the plane containing the axes of the limbs, preferably being arranged with the maximum diameters lying in the said plane.

In one such lamp comprising U-shaped discharge envelope having two parallel limbs each approximately 30 centimetres in length and in which the intermediate regions had a diameter of approximately 14 millimetres with the area of cross-section of the flattened regions approximately one half that of the intermediate regions, good results as regards the reduction in sodium migration have been obtained by providing in each limb of the

envelope three flattened regions each approximately 50 to 75 millimetres long separated by intermediate regions approximately 5 to 20 millimetres long. However, the most suitable dimensions of the flattened regions and intermediate regions, and the most suitable number for obtaining a satisfactory reduction in sodium migration in any particular lamp may readily be found by trial. Other arrangements of the flattened regions can, of course, also be employed. Thus in some cases the envelope wall in each flattened region of the envelope may be flattened on one side only of the tube axis, and in a lamp of this kind having a U-shaped discharge envelope provided in each limb of the envelope with a plurality of flattened regions, the flattened parts of the envelope wall can conveniently be formed in the sides of the two limbs of the envelope facing outwards away from each other, with the flattened parts of the two limbs parallel to one another.

In one lamp in accordance with the present invention having a U-shaped discharge envelope, the envelope is mounted within a single-walled evacuated outer jacket, and each limb of the envelope is individually provided, in accordance with the invention described in Patent Specification No. 801,482, with a sleeve of transparent heat-insulating material which fits closely round the limb and extends substantially the whole length thereof. However, the invention is also applicable to lamps of the kind employing a double-walled outer jacket, commonly known as a Dewar jacket, within which a U-shaped discharge envelope is arranged to be detachably mounted for operation of the lamp with air present in the space between the envelope and the inner wall of the outer jacket.

The temperature of the curved part of a U-shaped discharge envelope tends, in general, to be lower than the limbs, and in order to maintain this part at a high temperature the outer surface of the envelope at the curved end may be provided with a heat-reflecting coating, for example a layer of silver or platinum paint.

This assists in reducing any tendency for the sodium to migrate from the upper to the lower limb of the envelope in operation of the lamp.

However the invention is not restricted to lamps of the kind having a U-shaped discharge envelope, but can also be applied to lamps employing a discharge envelope in the form of a single straight tubular section having an electrode at each end.

In view of the increased current density within the flattened regions of the envelope of a lamp in accordance with the invention and the consequently increased temperature of the envelope wall in said regions at least the part of the envelope immediately bounding the discharge space should be formed of a glass which is highly resistant to hot sodium vapour so that it does not become appreciably discoloured in use of the lamp. One such glass is a borate glass having the following approximate composition by weight:—

B_2O_3	- -	25.0%
K_2O	- -	5.5%
CaO	- -	9.0%
BaO	- -	36.0%
Al_2O_3	- -	24.5%

Other suitable glasses will, however, be apparent to those skilled in the art of glass technology. In some cases the whole of the envelope may be formed of said sodium resistant glass although in general it will usually be more convenient to form the tubular envelope mainly of a different glass, for example, a common soda glass, provided with an internal coating of sodium resistant glass.

One lamp in accordance with the present invention having a U-shaped discharge envelope sealed within a single-walled evacuated outer jacket will now be described by way of example with reference to Figures 1 to 3 of the schematic drawing accompanying the provisional specification in which:—

Figures 1 and 2 represent a plan view and a side view respectively of the lamp with the outer jacket shown in part-section;

Figure 3 represents a transverse section through the lamp in the plane represented by the line XX of Figure 2.

Thus referring to the drawing the U-shaped tubular glass discharge envelope 1, which has two parallel straight limbs, each approximately 32 centimetres long joined by a short curved portion, is formed from two-ply tubing, consisting mainly of soda glass with an internal coating of sodium resistant borate glass, having an internal diameter of about 14 millimetres and a wall thickness of about 1 millimetre.

The envelope is filled with neon containing approximately 1.0% kryptron and 0.1% xenon at a total pressure of about 14 millimetre mercury.

The lamp electrodes 2, which are of the alkaline earth oxide kind employed in known forms of sodium lamp, are mounted near the ends of the discharge envelope to provide an arc length of approximately 600 millimetres.

The discharge envelope itself is mounted within a cylindrical glass outer jacket 3 of 50 milimetres external diameter and having a wall thickness of about 15 millimetre, the jacket being closed at one end by a hemispherical dome 4 and at the other end by a pinched foot-tube 5.

Two stout mounting wires 6 are sealed into the pinch 7 of the foot-tube, the ends of the wires within the jacket 3 being bent outwards away from each other as shown in Figure 1, and each being connected, for

example by spot-welding, to the ends of an appropriate pair of electrode leads 8. These mounting wires 6 connect the electrode leads 8 to the terminals 10 of a bayonet type lamp cap 11 secured to the adjacent end of the jacket by a suitable cement and also support the adjacent end of the discharge envelope 1 within the jacket. A circular mica disc 9, having slots through which the pinched ends of the limbs of the discharge envelope project, extends outwards into contact with inner surface of the outer jacket and assists in supporting the adjacent end of the discharge envelope against lateral movement within the jacket.

Over each limb of the discharge envelope 1 is fitted a cylindrical glass sleeve 12 (shown partly in section in Figures 1 and 2) having an internal diameter of approximately 18 millimetres and a wall thickness of about 0.5 to 0.75 millimetre, the sleeves extending substantially the whole length of the limbs.

A metal spring member 13 fits between the limbs at the curved end of the discharge envelope and is provided with outwardly-directed flanges 14 which bear against the adjacent ends of the sleeves and urge their opposite ends against the disc 9, the disc and the member thus supporting the sleeve against axial movement on the limbs; the disc 9 it itself held in position by means of a pair of metal starting wires 15 which are each connected to an appropriate one of the mounting wires 6, pass through corresponding holes in the disc, and are anchored at the opposite end of the envelope to a mica tap 16 carried by a spring clip 17 which fits over that end of the envelope 1 and supports it against transverse movement within the outer jacket as described in Patent Specification No. 815,782.

The spring member 13 is also provided with spring fingers 18 which extend into the space between the adjacent ends of the sleeves and the respective limbs of the envelope for preventing the ends of the sleeves from rattling on the limbs.

The outer jacket 3 is evacuated and contains two getter elements 19 attached to the mounting wires 6 on opposite sides of the foot-tube 5 for cleaning up residual gas and for maintaining the vacuum within the jacket during the life of the lamp.

In accordance with the invention each limb of the discharge envelope is formed with three flattened regions 20 each approximately 60 millimetres in length, the flattening being effected so that the major axis of each flattened region lies in the plane containing the axes of the two limbs of the discharge envelope; the flattened sides of each flattened region are substantially parallel to each other and to those of the other flattened regions and are internally spaced apart a distance of between 7 and 8 millimetres. The extreme ends of the two outer flattened regions are approximately equally spaced from the adjacent ends of the limbs and the intermediate regions of the envelope 21, which have the full cross-section of the tube, are approximately 15 millimetres in length.

With such a form of discharge envelope the rate of sodium migration is considerably reduced, and the light output is consequently maintained at a stable value for a longer period than would otherwise be the case.

The lamp, which is designed particularly for street lighting purposes, is arranged to be operated with the limbs approximately horizontal and with one directly above the other as is usually the case with known sodium vapour lamps of the kind having U-shaped discharge envelopes employed for street lighting. Since the internal diameter of the two limbs of the envelope in vertical planes is constant along the length of the limbs there is no reduction in the width of the discharge in vertical planes, and owing to the increased current density in the flattened regions the initial light output from the lamp in horizontal directions is significantly greater than that obtained from a similar lamp in which the envelope is formed of the same diameter tubing but not provided with flattened regions.

The flattening of the envelope is conveniently effected in manufacture of the lamp by heating the appropriate regions of the tubular envelope wall before sealing off to an appropriately high temperature, and pressing the heat-softened regions inwards between opposed dies whilst the pressure within the envelope is maintained at slightly greater than atmospheric pressure.

WHAT WE CLAIM IS:—

1. A sodium vapour electric discharge lamp of the type specified having a tubular discharge envelope formed from substantially circular section tubing having in the region between the electrodes at least one axially straight part, wherein the, or each said straight part of the envelope is formed with a plurality of flattened regions of relatively long axial length, separated by intermediate regions of relatively short axial length having the full substantially circular area of cross-section of the tubing, the flattened regions of the envelope each having an area of cross-section between one quarter and three-quarters that of the intermediate regions and having in each cross-section of the region a maximum diameter which is not les than that of the intermediate regions.

2. A sodium vapour electric discharge lamp according to Claim 1 wherein the cross-sectional area of each flattened region is approximately one half of that of the intermediate regions.

3. A sodium vapour electric discharge lamp according to Claim 1 or 2, wherein in each flattened region of the envelope, the envelope

wall is flattened on opposite sides of the tube axis, with the flattened parts of the envelope wall in said region lying parallel to each other.

4. A sodium vapour electric discharge lamp according to Claim 3 wherein the flattened parts of the envelope wall in the different flattened regions are all parallel to each other.

5. A sodium vapour electric discharge lamp according to any preceding claim wherein the maximum diameter of each flattened region is the same as that of the intermediate regions.

6. A sodium vapour electric discharge lamp according to any preceding claim incorporating a discharge envelope of U-shape having two parallel straight limbs formed by a short curved portion, wherein each limb of the envelope is formed with a plurality of said flattened regions.

7. A sodium vapour electric discharge lamp according to Claim 6 wherein the maximum diameters of the flattened regions of both limbs are parallel to the plane containing the axes of the limbs.

8. A sodium vapour electric discharge lamp according to Claim 6 or 7 wherein the discharge envelope is mounted within a single-walled evacuated outer jacket, and each limb of the envelope is individually provided with a sleeve of transparent heat-insulating material which fits closely round the limb and extends substantially the whole length thereof.

9. A sodium vapour electric discharge lamp according to Claim 8 wherein the outer surface of the envelope at the curved end is coated with a layer of heat-reflecting material.

10. A sodium vapour electric discharge lamp according to any preceding claim wherein at least the part of the envelope immediately bounding the discharge space is formed of a glass which is highly resistant to hot sodium vapour so that it does not become appreciably discoloured in use of the lamp.

11. A sodium vapour electric discharge lamp according to Claim 10 wherein the part of the envelope immediately surrounding the discharge space is a borate glass having the following composition by weight:—

B_2O_3	- -	25.0%
K_2O	- -	5.5%
CaO	- -	9.0%
BaO	- -	36.0%
Al_2O_3	- -	24.5%

12. A sodium vapour electric discharge lamp of the type specified substantially as shown in and as hereinbefore described with reference to Figures 1, 2 and 3 of the drawing accompanying the provisional specification.

For the Applicants:
J. E. M. HOLLAND,
Chartered Patent Agent.

PROVISIONAL SPECIFICATION

Improvements in or relating to Sodium Vapour electric discharge lamps

We, THE GENERAL ELECTRIC COMPANY LIMITED, of Magnet House, Kingsway, London, W.C.2, a British Company, do hereby declare this invention to be described in the following statement:—

This invention relates to sodium vapour electric discharge lamps of the positive column type having an enlongated tubular discharge envelope containing a pair of thermionically-emissive electrodes located at opposite ends of the envelope, a quantity of sodium for providing for a low pressure sodium vapour electric discharge between the electrodes in normal operation of the lamp, and a filling of rare gas for enabling the lamp to start and the sodium vapour electric discharge to be developed, and relates particularly to such lamps in which the region of the discharge envelope between the electrodes consists of or includes one or more axially straight parts that is to say one or more parts for which the corresponding length of the tube axis is straight.

The term "low pressure" implies that the lamp is of the kind in which the sodium vapour pressure in normal operation is much less than 1 millimetre mercury, usually about 0.01 millimetre mercury.

The form of sodium vapour electric discharge lamp which is in most common use at the present time has a discharge envelope in the shape of the letter U, consisting of two parallel straight limbs joined by a short curved portion, and surrounded by a heat-conserving outer jacket, the invention is particularly, though not exclusively, concerned with sodium vapour lamps of this kind.

One difficulty which has often been experienced with sodium vapour lamps of the type specified is that the sodium filling, which is preferably initially distributed along the length of the discharge path, tends to migrate, due to the phenomenon of thermal diffusion, towards the parts of the envelope which remain relatively cool in operation. Such parts may be a few in number and spaced widely apart, and this can result in other parts of the envelope becoming starved of sodium vapour, with a consequent reduction in the light output from those parts and a fall in the efficiency of the lamp as a whole.

The resultant loss in efficiency brought about by the migration of the sodium filling within the envelope often limits the useful life of a sodium lamp of the type specified to an undesirably low value, and the object of

the present invention is to provide a form of lamp in which this difficulty is reduced.

According to the invention in a sodium vapour electric discharge lamp of the type specified having a tubular discharge envelope formed with at least one axially straight part, the or each said straight part of the envelope is formed with a plurality of flattened regions of relatively long axial length and of relatively small area of cross-section, separated by intermediate regions of relatively short axial length having the full area of cross-section of the tube, with each flattened region of the envelope having in each cross-section of the region a maximum diameter which is not significantly less than that of the intermediate regions.

In the above statement of the invention and hereinafter the expression "cross-section" as applied to the discharge tube means the cross-section at right angles to the tube axis.

In operation of such a lamp the current density in the flattened regions is greater than that in the intermediate regions, and as a result the flattened regions are maintained at a higher temperature, the intermediate regions then constituting relatively cool parts of the envelope at which the sodium filling tends to collect due to thermal diffusion, the presence of the sodium in the regions thereby tending to keep the adjoining flattened regions supplied with sodium vapour in use of the lamp. The intermediate regions should, of course, be suitably closely spaced along the discharge envelope.

On the other hand the flattened regions should be sufficiently long, and arranged to operate at such a temperature with respect to the intermediate regions, that the transfer of sodium from one intermediate region to the next is substantially avoided. The temperature at which the flattened regions are maintained in use of the lamp will be determined by their cross-sectional area compared with that of the intermediate regions, and the smaller their cross-section the higher in general, will be their operating temperature. However the reduction in the area of cross-section in any of the flattened regions of the enevlope should not be so great that the voltage necessary for starting the lamp is excessively increased.

We have found that, in general, the temperature of the flattened regions can be maintained at a suitably high value compared with that of the intermediate regions by making the cross-sectional area of the flattened regions approximately $\frac{1}{4}$ to $\frac{1}{2}$ of that of the intermediate regions.

Preferably in each flattened region of the envelope, the envelope wall is flattened on opposite sides of the tube axis, with the flattened parts of the envelope wall in said region preferably lying parallel to each other.

Since the maximum diameter of each of the flattened regions of the envelope is not significantly less than the diameter of the intermediate regions, there will be no appreciable reduction in the width of the discharge in a flattened region as measured in the direction of the maximum diameters; the initial light output from a said flattened region perpendicularly to the maximum diameters will not, therefore, be significantly less than that obtainable in the same direction from a corresponding length of a similar lamp having the same cross-section as the intermediate regions, and may, in fact, be greater, depending upon the particular dimensions of the flattened region, in view of the increased current density. By a suitable choice in the number and size of the flattened regions the light output may in some cases be increased to such an extent that the total light output from the lamp as a whole is improved, despite the reduction in light output in directions parallel to the maximum diameters resulting from the narrowing of the discharge in the minimum width directions of the flattened regions.

In addition owing to the reduction in the rate of sodium migration the light output from a lamp in accordance with the invention is maintained more nearly constant over a longer period of time than is usually the case with sodium lamps of the type specified, the improved lumen maintenance thereby enabling a particularly long useful lamp life to be obtained.

Preferably the maximum diameter of each flattened region is the same as that of the intermediate regions. In some cases however it may be larger, although it will be appreciated that it should not be so large that the edges of the flattened regions provide relatively cold parts of the envelope at which the sodium condenses, since this could lead to the sodium gradually migrating along the edges from one intermediate region to another.

The reduction in light output in directions parallel to the said maximum diameters of the flattened regions will in many cases be an advantage rather than a disadvantage.

For example a light source designed for street lighting purposes is usually required to provide a light distribution having two directions of maximum intensity extending generally up and down the roadway, with the invensity falling off gradually below those directions to a minimum value immediately beneath the light source. In lamps in accordance with the present invention for use in street lighting and other purposes requiring a similar light distribution the different flattened regions of the envelope are preferably arranged parallel to each other. Such a lamp, when mounted with its axis horizontal, as is usually the case with sodium lamps, can then be arranged with the flattened regions approximately vertical, so that the directions of maximum light output extend approximately hori-

zontally outwards on opposite sides of the lamp axis; the light intensity in transverse vertical planes will then fall off gradually to a minimum value immediately beneath the lamp, thereby giving a light distribution of the form which is generally required for street lighting.

Where the lamp has a U-shaped envelope arranged to be mounted with one of the limbs of the envelope immediately above the other, the flattened reigons of both limbs of the envelope are preferably arranged parallel to the plane containing the axes of the limbs, preferably being arranged with the maximum diameters lying in the said plane.

In one such lamp comprising a U-shaped discharge envelope having two parallel limbs each approximately 30 centimetres in length and in which the intermediate regions has a diameter of approximately 14 millimetres with the area of cross-section of the flattened regions approximately ½ that of the intermediate regions, good results as regards the reduction in sodium migration have been obtained by providing in each limb of the envelope three flattened regions each approximately 50 to 75 millimetres long separated by intermediate regions approximately 5 to 20 millimetres long. However the most suitable dimensions of the flattened regions and intermediate regions, and the most suitable number for obtaining a satisfactory reduction in sodium migration in any particular lamp may readily be found by trial.

In one lamp in accordance with the present invention having a U-shaped discharge envelope, the envelope is mounted within a single-walled evacuated outer jacket, and each limb of the envelope is individually provided, in accordance with the invention described in Patent Specification No. 801,482, with a sleeve of transparent heat-insulating material which fits closely round the limb and extends substantially the whole length thereof. However the invention is also applicable to lamps of the kind employing a double-walled outer jacket, commonly known as a Dewar jacket, within which a U-shaped discharge envelope is arranged to be detachably mounted for operation of the lamp with air present in the space between the envelope and the inner wall of the outer jacket.

The temperature of the curved part of a U-shaped discharge envelope tends, in general, to be lower than the limbs, and in order to maintain this part at a high temperature the outer surface of the envelope at the curved end may be provided with a heat reflecting coating, for example a layer of silver or platinum paint.

This assists in reducing any tendency for the sodium to migrate from the upper to the lower limb of the envelope in operation of the lamp.

However the invention is not restricted to lamps of the kind having a U-shaped discharge envelope, but can also be applied to lamps employing a discharge envelope in the form of a single straight tubular section having an electrode at each end.

In view of the increased current density within the flattened regions of the envelope of a lamp in accordance with the invention and the consequently increased temperature of the envelope wall in said regions at least the part of the envelope immediately bounding the discharge space should be formed of a glass which is highly resistant to hot sodium vapour so that it does not become appreciably discoloured in use of the lamp. One such glass is a borate glass having the following approximate composition by weight:—

B_2O_3	- -	25.0%
K_2O	- -	5.5%
CaO	- -	9.0%
BaO	- -	36.0%
Al_2O_3	- -	24.5%

Other suitable glasses will, however, be apparent to those skilled in the art of glass technology. In some cases the whole of the envelope may be formed of said sodium resistant glass although in general it will usually be more convenient to form the tubular envelope mainly of a different glass, for example, a common soda glass, provided with an internal coating of sodium resistant glass.

One lamp in accordance with the present invention having a U-shaped discharge envelope sealed within a single-walled evacuated outer jacket will now be described by way of example with reference to Figures 1 to 3 of the accompanying schematic drawing in which:—

Figures 1 and 2 represent a plan view and a side view respectively of the lamp with the outer jacket shown in part-section;

Figure 3 represents a transverse section through the lamp in the plane represented by the line XX of Figure 2.

Thus referring to the drawing the U-shaped tubular glass discharge envelope 1, which has two parallel straight limbs, each approximately 32 centimetres long joined by a short curved portion, is formed from two ply tubing, consisting mainly of soda glass with an internal coating of sodium resistant borate glass, having an internal diameter of about 14 millimetres and a wall thicknes of about 1 millimetre.

The envelope is filled with neon containing approximately 1.0% kryptron and 0.1% xenon at a total pressure of about 14 millimetre mercury.

The lamp electrodes 2, which are of the alkaline earth oxide kind employed in known forms of sodium lamp, are mounted near the ends of the discharge envelope to provide an arc length of approximately 600 millimetres.

The discharge envelope itself is mounted

within a cylindrical glass outer jacket 3 of 50 millimetres external diameter and having a wall thickness of about 15 millimetre, the jacket being closed at one end by a hemispherical dome 4 and at the other end by a pinched foot-tube 5.

Two stout mounting wires 6 are sealed into the pinch 7 of the foot-tube, the ends of the wires within the jacket 3 being bent outwards away from each other as shown in Figure 1, and each being connected, for example by spot-welding, to the ends of an appropriate pair of electrode leads 8. These mounting wires 6 connect the electrode leads 8 to the terminals 10 of a bayonet type lamp cap 11 secured to the adjacent end of the jacket by a suitable cement and also support the adjacent end of the discharge envelope 1 within the jacket. A circular mica disc 9, having slots through which the pinched ends of the limbs of the discharge envelope project, extends outwards into contact with inner surface of the outer jacket and assists in supporting the adjacent end of the discharge envelope against lateral movement within the jacket.

Over each limb of the discharge envelope 1 is fitted a cylindrical glass sleeve 12 (shown partly in section in Figures 1 and 2) having an internal diameter of approximately 18 millimetres and a wall thickness of about 0.5 to 0.75 millimetre, the sleeves extending substantially the whole length of the limbs.

A metal spring member 13 fits between the limbs at the curved end of the discharge envelope and is provided with outwardly-directed flanges 14 which bear against the adjacent ends of the sleeves and urge their opposite ends against the disc 9, the disc and the member thus supporting the sleeves against axial movement on the limbs; the disc 9 is itself held in position by means of a pair of metal starting wires 15 which are each connected to an appropriate one of the mounting wires 6, pass through corresponding holes in the disc, and are anchored at the opposite end of the envelope to a mica tag 16 carried by a spring clip 17 which fits over that end of the envelope 1 and supports it against transverse movement within the outer jacket as described in co-pending Patent Application No. 10757/55.

The spring member 13 is also provided with spring fingers 18 which extend into the space between the adjacent ends of the sleeves and the respective limbs of the envelope for preventing the ends of the sleeves from rattling on the limbs.

The outer jacket 3 is evacuated and contains two getter elements 19 attached to the mounting wires 6 on opposite sides of the foot-tube 5 for cleaning up residual gas and for maintaining the vacuum within the jacket during the life of the lamp.

In accordance with the invention each limb of the discharge envelope is formed with three flattened regions 20 each approximately 60 millimetres in length, the flattening being effected so that the major axis of each flattened region lies in the plane containing the axis of the two limbs of the discharge envelope; the flattened sides of each flattened region are substantially parallel and are internally spaced apart a distance of between 4 and 5 millimetres. The extreme ends of the two outer flattened regions are approximately equally spaced from the adjacent ends of the limbs and the intermediate regions of the envelope 21, which have the full cross-section of the tube, are approximately 15 millimetres in length.

With such a form of discharge envelope the rate of sodium migration is considerably reduced, and the light output is consequently maintained at a stable value for a longer period than would otherwise be the case.

The lamp, which is designed particularly for street lighting purposes, is arranged to be operated with the limbs approximately horizontal and with one directly above the other as is usually the case with known sodium vapour lamps of the kind having U-shaped discharge envelopes employed for street lighting. Since the internal diameter of the two limbs of the envelope in vertical planes is constant along the length of the limbs there is no reduction in the width of the discharge in vertical planes, and owing to the increased current density in the flattened regions the initial light output from the lamp in horizontal directions is significantly greater than that obtained from a similar lamp in which the envelope is formed of the same diameter tubing but not provided with flattened regions.

The flattening of the envelope is conveniently effected in manufacture of the lamp by heating the approporiate regions of the tubular envelope wall before sealing off to an appropriate high temperature, and pressing the heat-softened regions inwards between opposed dies whilst the pressure within the envelope is maintained at slightly greater than atmospheric pressure.

For the Applicants:
J. E. M. HOLLAND,
Chartered Patent Agent.

[redacted]

P.T.O.

865,928 PROVISIONAL SPECIFICATION
1 SHEET
This drawing is a reproduction of the Original on a reduced scale.

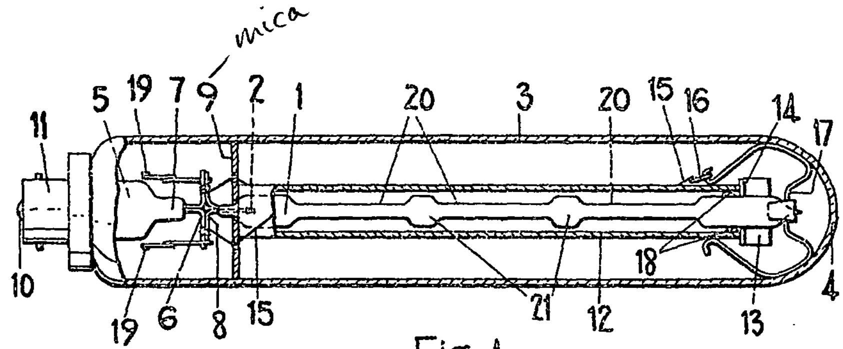

Fig. 1

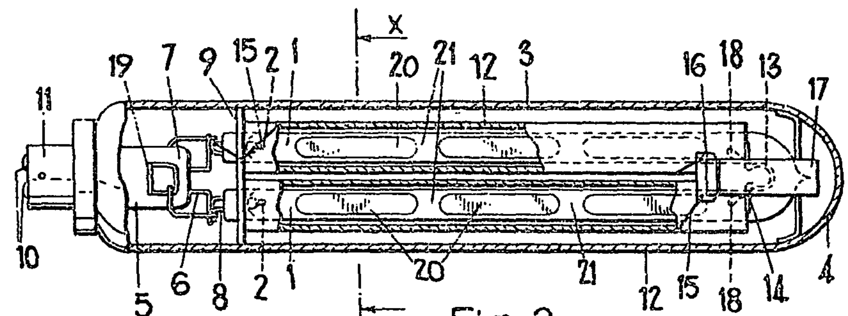

Fig. 2

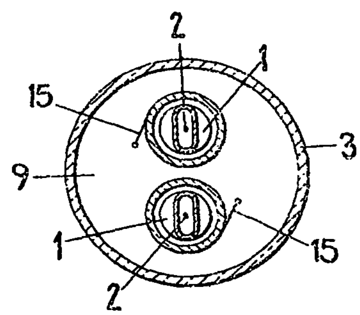

Fig. 3